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Gypsy Moth Handbook

The Homeowner and the Gypsy Moth: Guidelines for Control

Contents

In 1974 the U.S. Department of Agriculture initiated the Combined Forest Pest Research and Development Program, an interagency effort that concentrated on the Douglas-fir tussock moth in the West, on the southern pine beetle in the South, and on the gypsy moth in the Northeast. The work reported in this publication was funded in whole or in part by the program. This manual is one in a series on the gypsy moth.

The Homeowner and the Gypsy Moth: Guidelines for Control

by
Michael L. McManus, David R. Houston, and William E. Wallner [1]

Introduction

The gypsy moth is the most important defoliating insect of hardwood trees in the Eastern United States (fig. 1). Since the turn of the century, millions of dollars have been spent in efforts to control or eliminate gypsy moth populations and to retard natural and artificial spread. In the early decades of this century, outbreaks occurred only in New England; today defoliation by the gypsy moth is far more severe and widespread (fig. 2).

The gypsy moth has always been a "people problem." Defoliation often occurs in populated areas, especially where homes and developments are located in previously forested land (fig. 3). Under these conditions, the gypsy moth defoliates not only woodland trees but also valuable park and ornamental trees. Because the insect is firmly established in the densely populated regions of the Eastern United States, it is very likely that you, the homeowner in this area, and the gypsy moth will meet.

In urban situations, gypsy moth larvae (caterpillars) are a major nuisance as they defoliate shade and ornamental trees, crawl over everything—homes, outdoor

[1]Respectively, program coordinator, principal plant pathologist, and research entomologist, U. S. Department of Agriculture, Northeastern Forest Experiment Station, Hamden, Conn.

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Figure 1.—Late-stage gypsy moth larva.

Figure 2.—Extensive defoliation on ridgetops caused by gypsy moth.

Figure 3.—Partial defoliation around suburban homesite.

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Figure 4.—Hungry larvae crawling over home.

Figure 5.—Nuisance of larvae and frass on picnic table.

furniture, lawns—and leave debris from their feeding (figs. 4 and 5). Should it occur, the death of defoliated trees and the often substantial cost of their removal and replacement can add to the homeowner's distress.

Although the gypsy moth is well established as a component of the predominantly oak hardwood forest community of North America, there are ways to minimize its adverse effects on trees and to reduce its impact on people. Use this guide to acquaint yourself with the habits of the gypsy moth, maintain active surveillance for its presence or increase, and use those procedures that are most appropriate for your situation. If you are uncertain about which actions to take, consult with a representative of the county cooperative extension office, the State agriculture service, or the U. S. Department of Agriculture, or contact specialists at a nearby university or agricultural experiment station.

Life History and Life Stages

Egg Masses

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The female gypsy moth deposits her eggs in a well-formed egg mass (fig. 6) in June or July and dies shortly thereafter. An egg mass may contain from 75 to 1,000 eggs. It is buff colored when first laid but may bleach out over the winter months when exposed to direct sunlight and weathering.

Egg-mass size is an indicator of the status of a gypsy moth infestation. Declining outbreaks are characterized by the presence of many small masses (approximately 0.5 in long) that contain as few as 75 to 100 eggs. In static or growing populations, the egg masses are fewer in number but larger (1.5 in long) and contain from 700 to 1,000 eggs.

Figure 6.—Female moth depositing egg mass.

Egg Hatch and Spread of Larvae

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Gypsy moth larvae usually begin emerging from individual egg masses in late April or early May. Initial hatch is determined primarily by temperature and usually coincides with budbreak of most hardwood trees. The eggs in an individual egg mass will hatch completely over a period of 3 to 5 days, but in an infested area eggs may hatch over a period of 2 to 3 weeks, depending on the location of egg masses and their exposure to sunlight. Newly hatched larvae are buff colored but turn black within 4 hours after emergence (fig. 7). They remain on or around the egg mass for several days if temperatures are below 40° F or if it is raining.

When conditions are favorable, larvae leave the egg mass and climb trees in response to overhead light. They produce silk from glands located in their head

Figure 7.—Egg mass hatching in early spring; buff-colored larvae have emerged most recently.

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and lay down a trail of silk continually as they move (fig. 8). When larvae reach the outer branches or tops of trees, they drop on silken threads (fig. 9) that are easily fractured by slight gusts of wind. Both the silk strand and long lateral hairs (fig. 10) add buoyancy to the windborne insects. In woodland situations, larvae may go through several windblown dispersals before settling down to feed. Although some larvae may be carried for long distances by wind, most spread results in massive redistribution of the population within relatively local areas.

Figure 8.—Newly hatched larvae trailing silk prior to dispersing.

Figure 9.—Larva suspended on a silken thread.

Figure 10.—First-stage larva with long lateral hairs.

Early-Stage Larvae

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After dispersing, larvae begin feeding when they encounter acceptable food plants, which include many species. In some years, larval emergence and dispersal may occur prior to leaf expansion of favored tree species such as the oaks; usually however, larvae can sustain themselves by feeding on tree buds and on many understory plants or shrubs until trees bear leaves.

First-stage larvae, which usually have two or three feeding periods during the day, chew small holes within the perimeter of the leaf (fig. 11). When not feeding, they rest on a mat of silk they have made on the underside of a leaf. Male larvae molt (shed the outer skin) through five stages, females through six. Each larval stage lasts 4 to 10 days, the time dependent mainly on temperature during each developmental stage.

Second- and third-stage larvae (fig. 12) feed at the leaf margins and characteristically stay in the tree tops, migrating to the undersides of branches and twigs when not feeding.

Figure 11.—Typical feeding damage caused by young larvae.

Figure 12.—A third-stage larva.

Late-Stage Larvae

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After molt to the fourth stage (fig. 13), larval behavior changes dramatically. Larvae feed during the night, then descend the trees at dawn in search of protective locations where they rest for the remainder of the day. At dusk they climb the trees again to feed. The movement up and down the tree is apparently triggered by light intensity. It is during this stage of development that defoliation can be severe enough to be noticed.

Larvae prefer to rest under bark flaps or other structures on trees (fig. 14). If no hiding place is available on trees, the insects will descend to the ground and rest

Figure 13.—Newly emerged fourth-stage larva.

Figure 14.—A bark flap provides protection for gypsy moth larvae and pupae.

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beneath leaf litter (fig.15), dead stumps, or other nearby objects. Here they are often vulnerable to attack by small mammal predators such as mice, shrews, and insects such as ground beetles. At very high densities, the larvae follow a different pattern of behavior—they remain on the foliage and feed continuously day and night (fig. 16).

Figure 15.—Late-stage larvae resting in leaf litter at base of tree.

Figure 16.—Foliage being stripped by many late-stage larvae.

Pupae


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Larvae usually complete their development in late June or early July, attach themselves to a surface with strands of silk, and then transform into pupae (fig. 17). Usually this is in the same locations where they rested as late-stage larvae. Pupation lasts about 2 weeks. Males usually pupate before females because they pass through one less larval stage. The mahogany-colored pupae are immobile and defenseless and are vulnerable to many different predators and parasites. Female pupae are usually larger than male pupae (fig. 18); however, in dense populations where available foliage is limited, female and male pupae may be the same size.

Figure 17.—Newly formed pupae attached to bark with silken threads.

Figure 18.—Male (left) and female pupae.

Adults

Male moths usually emerge before females (fig. 19). Males are strong fliers and are usually most active within the forest canopy during daylight hours. They fly in zigzag patterns and can be seen searching up and down tree trunks for female moths.

The female moth has well-developed wings but cannot fly. She compensates for this by releasing a strong sex attractant from her abdomen that lures male moths to her location. Soon after mating occurs, the female deposits her eggs in a single mass, usually in the same location where she pupated.

19*A*

Figure 19.—Adult moths: *A*, Male; *B*, female.

19*B*

Detecting the Gypsy Moth

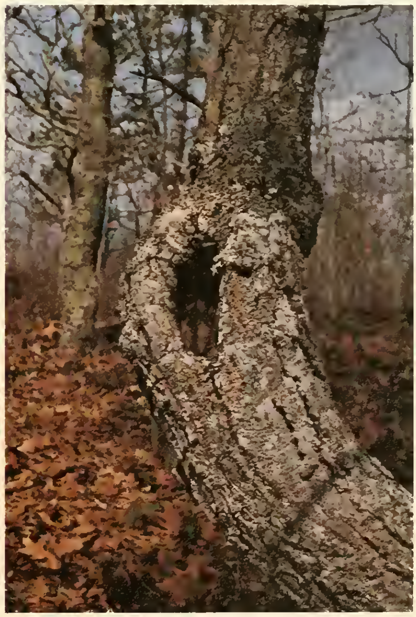
The presence of the gypsy moth often goes unnoticed until trees are partially defoliated. This section describes how and where to find the insect's life stages before they become so numerous as to cause damage.

20*A*

Figure 20.—Good places to check for egg masses: *A*, Bark flaps; *B*, holes in trees.

Egg Masses

Gypsy moth egg masses are the life stage most often observed, mainly because they are present in the field from July to May and persist even after the larvae emerge. New egg masses are firm to the touch; hatched egg masses are soft and spongy. Although egg masses may be found anywhere from in the leaf litter on the forest floor to the tops of trees, most are laid on the trees, especially in protected refuges such as bark flaps, crevices, and holes (fig. 20).



20*B*

In suburban areas, egg masses are frequently found in woodpiles, rock walls, or other protected locations around or on homes. Homeowners should also check lawn furniture, behind shutters, underneath tree houses, and beneath lower rows of shingles on a house or garage (fig. 21).

21*A*

21*B*

21*C*

21*D*

Figure 21.—Suburban areas where egg masses can be found: *A*, Woodpile at the base of this tree is a likely place to find egg masses; *B*, stone walls may contain many egg masses and other life stages; *C*, old pupal skins and a hatching egg mass at base of same stone wall; *D*, tree houses also make good homes for gypsy moths.

Larvae and Pupae

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When the feeding and resting behavior of late-stage larvae changes, they search out places to rest during the day either on the trees or on the ground. Ultimately the larvae pupate in these same places (fig. 22). Burlap bands or skirts placed about tree trunks of preferred species such as oaks can aid the homeowner to detect the presence of gypsy moth larvae before noticeable defoliation occurs. Larvae climbing down the trees early in the morning will locate and crawl beneath the burlap where they can be observed or periodically removed and destroyed.

Burlap bands or skirts should be less than one-half the diameter of the tree wide and should be attached at about 5 ft above the ground. The burlap should be folded in half and either stapled to the tree from within the fold or draped over a piece of string or rope which is then tied around the tree (fig. 23). It is important that the folded burlap is loosely attached to the tree so that the larvae are able to crawl beneath it from either the bottom or the sides.

Figure 22.—Larvae and pupae readily use bark flaps for resting sites.

Figure 23.—Burlap band (attached with twine) containing gypsy moth pupae.

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Various reports indicate that gypsy moth larvae can feed on at least 500 species of plants that include trees, shrubs, and vines. This host list will continue to grow as the gypsy moth spreads to the South and West. For example, it has recently been shown that gypsy moth larvae can successfully feed and develop on many cultivated trees, shrubs, and vines important to agriculture in California.

In the East, the gypsy moth's favorite trees include apple, speckled alder, basswood, gray and river birch, hawthorne, oak, poplar, and willow. Less desired but still attacked are black, yellow, and paper birch, cherry, cottonwood, elm, blackgum, hickory, hornbeam, larch, maple and sassafras. Older gypsy moth larvae devour the foliage of several species that younger larvae normally avoid, such as hemlock, southern white cedar, and the pines and spruces native to the East.

The gypsy moth avoids ash, balsam fir, butternut, black walnut, catalpa, red cedar, flowering dogwood, American holly, locust, sycamore, and yellow or tulip poplar, and shrubs such as mountain laurel (fig. 24), rhododendron, and arborvitae.

This list is provided only as a guideline for possible consideration in choosing landscape plantings. The susceptibility of less preferred species to defoliation also depends upon the species composition of forests in the surrounding area and the severity of nearby infestations.

Figure 24.—Laurel was ignored by larvae, although surrounding trees were defoliated.

Effects of Defoliation on Trees

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One must see an episode of severe defoliation by the gypsy moth to appreciate fully the dramatic impact this insect can have. Most noticeable, of course, is the great change in appearance of yards and gardens, when autumn appears to have arrived months ahead of time. Sometimes these visual effects are temporary, lasting but a few weeks until a new set of leaves is produced.

Sometimes, however, because trees may be seriously weakened by defoliation, the effects are long lasting. Tree tops may become thin and off color, and buds and branches may die (fig. 25); some trees may die altogether.

Whether or not a tree succumbs to defoliation by the gypsy moth depends on three main factors: Tree condition, the number and severity of prior defoliations, and the presence of organisms that attack and kill stressed trees.

Figure 25.—Dieback of upper branches on a stressed tree.

Tree Condition

Trees weakened by construction (by being wounded, by water being altered, or by sudden exposure to drying winds or bright, hot sun) or by other stress agents such as too little or too much water, frosts, leaf diseases, or herbicides are likely to suffer more drastically from gypsy moth defoliation than healthy, nonstressed trees. But even healthy trees can suffer from defoliation if enough of their leaves are removed in successive years.

Number and Severity of Previous Defoliations

How severely can trees be defoliated and not suffer? How often can this occur before trees are adversely affected? Although there are no simple answers to these questions, a general rule is that a tree is seriously affected by defoliation when enough leaves are removed to cause it to produce a second crop of leaves in the same growing season. This process is called refoliation.

Because leaves produce the food required by the tree for life and growth, any reduction in their numbers, no matter how small, reduces the amount of food manufactured. But because most trees produce more food than they need to survive, they can tolerate some loss of leaves. Indeed, loss of up to about half the leaves results in little more than reduction in growth. But when *more* than half of the leaves are eaten, not enough food and other substances needed for growth are produced; this situation triggers the process of refoliation. When *all* the leaves are eaten and *no* food is produced, the tree must subsist on its reserve foods until new leaves are formed. Gypsy moth defoliation is especially detrimental because it occurs at precisely the most critical time for the tree—when growth is most active and when food reserves are at their lowest normal levels.

26*A*

26*B*

When enough leaves are eaten to cause the tree to refoliate, changes occur both outside and inside the tree. After 2 to 3 weeks, buds begin to open and a second crop of leaves develops. These leaves are often smaller and are a lighter green than those produced in spring (fig. 26). Inside the tree, defoliation and the refoliation process have markedly reduced the amount of food energy reserves, energy that the tree needs to maintain itself during the winter dormant period and to produce buds and twigs in the early spring. Low energy reserves, together with the desiccation of immature buds produced during refoliation, will result in the death of buds, twigs, and branches during winter months.

If no defoliation occurs the following year, most trees (except for trees already in poor condition) will survive and regain their former fullness. But defoliation, even at low levels, can be harmful if repeated for several years; even healthy trees may die if they go through the defoliation/refoliation process for 2 or 3 years in succession.

Figure 26.—Refoliated leaves of defoliated trees (*A*) are usually smaller and lighter green than normal leaves (*B*).

The final blow to most defoliated trees is dealt by opportunistic organisms that can successfully attack and kill trees stressed by defoliation. One of these organisms, the shoestring root-rot fungus, *Armillaria mellea*, enters the bark and wood of weak, dying, or dead roots. The fungus grows rapidly between the bark and wood of the roots and root collar (fig. 27) and can kill the tree quickly. *Armillaria* also can decay tissues of the roots that store food or that absorb and transport food, water, and minerals. In addition, death of small roots may start a cycle of decline that can result in the tree's death.

Another organism that can invade oaks weakened by defoliation is the twolined chestnut borer, *Agrilus bilineatus*. This insect attacks and chews feeding tunnels under the bark of branches and tree trunks (fig. 28). These tunnels in the outer wood and inner bark interfere with the passage of food, water, and minerals causing the death of more branches and roots.

The combined attacks by the shoestring fungus in the roots and root collar and the twolined chestnut borer in the branches and stems usually result in tree death. Often, attacked trees die so rapidly, especially in late summer, that their leaves suddenly wilt and turn brown.


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Figure 27.—Dead oak tree with bark removed to show white fans of the shoestring root-rot fungus.

Figure 28.—Dead oak tree with bark removed to show feeding tunnels of the twolined chestnut borer.

The Natural Enemy Complex

There are two approaches to preventing or alleviating the problems of gypsy moth invasions: One is directed against the insect; the other is designed to improve the growing conditions for trees around the home.

In addition to knowing about the gypsy moth and the damage it inflicts, you should be aware of the many natural enemies that collectively destroy it, because the actions you select to control the gypsy moth may also affect these many beneficial organisms.

The natural enemy complex, which is composed of parasites, predators, and disease, does not control the gypsy moth in outbreak situations but does aid in maintaining certain sparse gypsy moth populations at low levels. It may also help to extend the period of years between outbreaks. Disease is the major factor in halting outbreaks, but unfortunately this occurs only after the full impact of gypsy moth defoliation has been realized.

Parasites

Parasites are living organisms that make their homes on or in the bodies of other living organisms (hosts) from which they get nourishment during at least one stage of their life. A parasite usually requires only a single individual of the host species to complete its development.

In North America, there are about a dozen species of parasites that attack various gypsy moth life stages, and their abundance varies greatly from place to place and year to year.

Several species of small wasps attack the various life stages of the gypsy moth. One of the most common species, *Ooencyrtus kuvanae*, attacks the eggs wherever they occur, resulting in small pinholes on the surface of the egg mass (fig. 29). *Apanteles melanoscelus* attacks and kills small larvae (fig. 30), and *Brachymeria intermedia* (fig. 31) stings gypsy moth pupae but is most effective only when gypsy moth populations are at defoliating levels.

Three species of flies that are slightly larger than the common house fly attack large larvae and are important parasites of the gypsy moth. One of them, *Parasetigena agilis*, lays its eggs near the head of the larvae (fig. 32). The maggots (or larvae) of these flies develop to maturity within gypsy moth larvae and pupae, leaving only the outer shells behind (fig. 33).


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Figure 29.—Weathered egg mass showing pinholes caused by egg parasite.

Figure 30.—Attached cocoons of a wasp that kills young larvae.

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Figure 31.—A small wasp that stings gypsy moth pupae.

Figure 32.—Eggs of a fly parasite attached to late-stage larva.

Figure 33.—Maggots of parasite fly eventually destroy the pupae, leaving only the outer shell.

Predators


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Whereas parasites are usually smaller than the host they attack and develop within a single individual, predators usually are larger than their prey and consume many host insects during the course of their life. They are very active, live longer, and are opportunistic in that they may prey upon a variety of insects, depending on what is available.

Although predators destroy many life stages of the gypsy moth, their importance has probably been underestimated because they consume their prey quickly and leave few if any remains. Woodland mammals can consume large numbers of gypsy moth larvae and pupae in forested areas. Some mammals eat only one life stage of gypsy moth, while others may eat as many as three. Some mammalian predators of the gypsy moth include the white-footed mouse (fig. 34), shrews, chipmunks, voles, and squirrels. Shrews, which are often mistaken for mice, are voracious insect feeders (fig. 35) that consume their own weight in prey each day. Unfortunately, mice and shrews are probably not important as predators in suburban settings because they are eliminated by domestic animals such as the common cat and because their natural habitat, forest litter, is frequently destroyed.

Figure 34.—White-footed mice eating larvae.

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Many species of birds have been observed feeding on gypsy moth larvae or adults. Nuthatches, chickadees (fig. 36), towhees, vireos, northern orioles, catbirds, robins, and blue jays are probably more important in sparse gypsy moth populations. Cuckoos (fig. 37) and flocking species such as starlings, grackles, red-winged blackbirds, and crows may be attracted to areas where the gypsy moth exists in large numbers.

Figure 35.—Shorttail shrew eating larva.

Figure 36.—The black-capped chickadee feeds on all gypsy moth life stages.

Figure 37.—The black-billed cuckoo prefers hairy caterpillars like the gypsy moth.

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Less is known about the importance of insect or insect-related predators of the gypsy moth, although more is being learned about their importance. Ground beetle larvae and adults feed readily on gypsy moth larvae and pupae (fig. 38) and are usually most evident when gypsy moths are numerous. These beetles are very active and readily climb trees in search of their prey. Many gypsy moth larvae and pupae that rest on or near the ground are destroyed by spiders (fig. 39), ants, and harvestmen (daddy longlegs). The collective value of these organisms has not been widely recognized because they are less conspicuous than other predators, and their activities are difficult to monitor.

Figure 38.—This ground beetle destroys both larvae and pupae.

Figure 39.—Many kinds of spiders kill gypsy moths.

Disease

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There are many diseases caused by bacteria, fungi, or viruses that kill gypsy moth larvae. Only one, however, the nucleopolyhedrosis virus (NPV), has a dramatic effect on gypsy moth populations, frequently resulting in the total collapse of outbreaks. Virus-killed larvae are commonly seen hanging in an inverted V-shaped form from trees (fig. 40); their bodies are dark and flaccid and contain only liquified material composed mainly of the infectious virus. Large numbers of virus-killed larvae usually indicate a general collapse caused by the virus.

Figure 40.—Larva killed by disease caused by a natural virus.

Guidelines for Tree Survival

Maintain Good Conditions for Growing Trees

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Trees that are stressed are more vulnerable to defoliation and the opportunistic organisms that frequently attack them, so efforts should be made to keep trees in a good state of health or vigor. Nearly all the recommendations discussed here emphasize the importance of maintaining good soil nutrient and moisture relationships.

• Keep soil conditions favorable for the development and survival of the tree's fine feeder root system. Construction activities such as cutting and filling, installing utility and septic tank field lines, changing grades, paving, and cutting down the surrounding forest may have harmful effects on soil/moisture relations. A general rule is to do no more than is necessary.

• In wooded backyards, or in yards where lawns and forests meet, an attempt should be made to keep the forest floor surface as natural as possible (fig. 41). Because oaks thrive under acid soil conditions, removal of their organic acid-rich leaf litter can be harmful. Layers of natural leaf litter help prevent drying out surface soil layers that contain the bulk of the tree's feeder roots and provide a natural habitat for predators such as mice and shrews that prey upon gypsy moth larvae and pupae.

• Growth conditions for isolated trees planted on lawns can be enhanced by encircling them with mulch or ground cover plants (when practical) out to an area delimited by the outer branches. A dense grass layer over feeder roots causes severe competition for moisture and nutrients. Applications of lime or weed killers around forest trees can seriously damage shallow tree roots.

• In times of drought, stressed individual trees can also benefit from watering, fertilizing, and judicious pruning to thin the tree tops and reduce moisture demands on the roots.

Figure 41.—Wooded areas adjacent to lawns should be kept in a natural state.

Discourage Survival and Destroy Life Stages


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There are other practices that directly affect the insect itself, especially in sparse populations, and that should be considered as part of a total preventive program around the home.

- Remove objects around the yard that provide shelter for gypsy moth larvae and pupae and increase their chances for survival. These include natural objects such as bark flaps, dead branches (fig. 42) and trees, stumps, and debris on the ground such as boxes, cans, or old tires.

- Diversify composition of trees and plants or encourage those species that are known to be unpopular with the insect. Species such as tulip or yellow poplar, honeylocust, ash, maple, hickory, dogwood, mountain ash, and many conifers can be incorporated into a landscaping plan that will make your property less susceptible to gypsy moth and other defoliators as well. Check first with your nurseryman, arborist, or county cooperative extension agent to select those tree species that are most compatible with your particular climate and soil and site situation.

- During the winter months, remove and destroy egg masses that are found on or around homes and premises. Carefully inspect buildings such as toolsheds, garages, and tree houses, as well as stone walls, woodpiles, and fencing for hidden egg masses. Check lawn chairs and other yard equipment for egg masses before storing them away for the winter.

Figure 42.—Dead branches and bark flaps should be removed.

43


44


Figure 43.—Many gypsy moth larvae resting beneath burlap skirt.

Figure 44.—This maple was disfigured where a homeowner placed a band of sticky material around the tree.

• Place burlap on trees, especially oaks, and destroy gypsy moth larvae and pupae that hide beneath during daylight hours (fig. 43). The burlap also aids in keeping tabs on numbers of the insect and encourages activity by resident parasites and predators that search out protected locations for larvae and pupae.

• Placing a band of sticky material (such as grease, tar, or other petroleum product) around trees to entrap gypsy moth larvae is not encouraged. These materials can cause injury (swelling and cankering) on thin-barked trees such as maples and young oaks (fig. 44).

Protect Foliage From Defoliation

Under normal circumstances, when few insects are observed, annual protective spraying of pesticides on trees and shrubs around the home to control the gypsy moth is probably not justified and may have an adverse effect on the insect's natural enemy complex. Your decision to use or not use pesticides should be influenced by environment, economics, and practical concerns as they relate to the following:

Number of and kind of trees—Is there a large proportion of preferred hosts on your property?

Tree condition—Are your trees showing signs of decline (dead or dying branches) especially near the top?

Proximity to other areas of infestation—Is your property located adjacent to areas heavily infested with gypsy moth? (Windblown first-stage larvae and migrating late-stage larvae in search of food can infest your property.)

History of past infestation—Were your trees recently defoliated by gypsy moth or other insects?

Indications of anticipated severity—Have you observed gypsy moth larvae feeding on your trees, resting under bark flaps, burlap bands, or in other protected locations? Are gypsy moth larvae numerous enough to be considered a nusiance to you on your property?

If the answer to three or more of these questions is yes, then you should consider the use of a chemical or biological pesticide to protect foliage of your trees and to reduce the number of gypsy moths. There are several pesticides registered for control of the gypsy moth. To obtain the most current recommendations on pesticides and their application in your area, you should contact a county cooperative extension agent, State entomologist, nurseryman, arborist, city or State forester, or specialists at your State university or agricultural experiment station.

Acknowledgments

Figure 4 is used through the courtesy of the Connecticut Agricultural Experiment Station, New Haven.

We thank the Encyclopaedia Britannica Educational Corporation for kindly allowing the use of figures 36 and 37, which were copyrighted 1962–64.

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